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INTERBANK NETTING AGREEMENTS AND THE DISTRIBUTION OF BANK DEFAULT RISK

ABSTRACT

Central banks and private banks alike have advocated greater use of interbank netting agreements in recent years in order to reduce potential for transmitting economic shocks through interbank markets. This paper provides a model of an interbank payment market and shows that one side-effect of greater netting of interbank claims is a redistribution of bank default risk away from interbank claimants toward non-bank creditors of banks, including the deposit insurer. Interbank netting agreements thus involve a trade-off between reduced interbank credit-risk exposure and increased concentration of bank default risk on other sets of bank creditors.

KEYWORDS: netting agreements, bank default risk, deposit insurance

JEL CLASSIFICATION: G28, G21, E58

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Interbank Netting Agreements and the Distribution of Bank Default Risk

The Federal Deposit Insurance Corporation Improvement Act of 1991 (FDICIA) provided support for netting contracts among banks and other regulated financial institutions in order to lessen systemic risk (Parkinson 1993, p. 63; Wall 1993, p. 5). Important types of interbank netting agreements include bilateral payments netting, multilateral payment systems with net settlement, and master derivative agreements. Proponents of these netting agreements point out that netting generally reduces the interbank credit exposures faced by individual banks. Thus, a liquidity or solvency problem at one bank is less likely to create a "domino effect" in the interbank market since the transmission channels for such a shock have been reduced in absolute magnitude. In the case of multilateral netting, the average reduction in credit-risk exposures faced by banks after netting may be of an order of magnitude or more.

The proposition that interbank netting reduces systemic risk has an important corollary that is often left unstated. The corollary is that, as a result of interbank netting agreements, bank default risk is redistributed to those participating banks' creditors whose claims are not included in the netting agreement. These excluded creditors may consist of uninsured depositors and other non-bank liability holders, respondent banks, holders of various types of bank equity securities, the central bank, and, of course, the deposit insurer and ultimately the taxpayer. If any of these creditor classes are unsuited for risk-bearing or are not properly compensated for the increased risks they bear, then the risk-shifting aspect of interbank netting schemes presents a negative offset to the benefits associated with them.

This paper provides a model of an interbank payments market and then characterizes the redistribution of bank default risk that arises from interbank netting agreements. The paper identifies the efficiency trade-offs that accompany netting agreements, making explicit the substitution of concentrated bank default-risk exposure for reduced interbank, or systemic, risk exposure. To highlight the redistributive aspects of interbank netting agreements, I posit a very simple liability structure for banks, consisting only of insured non-bank deposits, uninsured interbank claims, and equity. It becomes clear in this framework that the direct economic losses that cause a bank to fail (*e.g.,* loan losses) cannot be eliminated by interbank agreements, although they may be redistributed. Thus, the case for interbank netting agreements can be recast as a statement about the relative efficiency of various risk-sharing arrangements in the banking system. This applies equally to payments and over-the-counter financial markets that utilize interbank netting agreements.

The main result of the paper implies that interbank netting agreements are beneficial only if the holders of non-netted claims on a failing bank-- in this model, the deposit insurer-- can more efficiently bear the losses caused by the bank's failure *by themselves* than could the bank's creditors as a whole. Stated in this way, it is clear that commonly expressed arguments in favor of interbank netting agreements are at their core also statements about the relative risk-bearing capabilities of various agents and institutions. It is quite possible that concentrated risk-bearing is beneficial on balance, since this provides incentives for effective delegated monitoring. However, it bears pointing out that the endorsement of interbank netting agreements, such as that contained in FDICIA, implies the acceptance of an heightened degree of responsibility on the part of the deposit insurer and other non-bank creditors for the risks incurred in, and more broadly, the stability of, the banking system.

The first section of the paper describes a simple model of interbank payments without netting agreements, a central bank, or deposit insurance. Section II adds a deposit insurer and shows that "delegated monitoring" by this institution on behalf of depositors generates important efficiency gains. Section III illustrates both bilateral and multilateral interbank netting agreements in an economy with deposit insurance, pointing out how these arrangements alter the *ex ante* distribution of bank default risk. Section IV illustrates the main result of the paper with a small-scale example. The role of a central bank in the interbank payment system is discussed briefly. The paper's final section concludes.

I. A Model of Interbank Payments

This section describes a model of interbank payments without deposit insurance, netting agreements, or a central bank. Subsequent sections address these arangements, in turn.

Agents. The model economy lasts for two periods and consists of a large number of risk-neutral agents who are identical at T=0, the beginning of the first period. The economy's agents are initially uniformly geographically dispersed among N neighborhoods, each of which contains M members. Hence, there are MN agents in all. Each agent begins with one unit of a consumption good and seeks to maximize his or her consumption of the good at the end of period two, T=2. The rate of time discounting of consumption is zero.

Each agent receives an idiosyncratic "geographic-preference shock" at the beginnning of period one (which lasts from T=0 and T=1) indicating the neighborhood to which the agent must move in order to derive utility from consumption at T=2.[1] *Ex ante*, each agent is equally likely to prefer any one of the economy's other N-1 neighborhoods over his or her original location. The number of agents who wish to move from any given neighborhood i to another neighborhood j in the economy is given by $x_{ij} \in [0, M]$, i,j=1,...,N, where $x_{ii} = 0$, and $\sum_{j=1}^{N} x_{ij} = M$ for each i. A complete description of the movements of agents originating in any neighborhood *i* is given by $\{x_{i1}, x_{i2}, \ldots, x_{iN}\}$, while a summary of the agents arriving in neighborhood *i* is given by $\{x_{1i}, x_{2i}, \ldots, x_{Ni}\}$.

Let the expected number of agents that wish to move from neighborhood *i* to any other neighborhood *j*, $E[x_{ij}]$, be denoted *X*, which clearly lies between zero and *M*. This quantity is the *gross* expected movement of agents from one location to another. We will also have occasion to discuss the *net* expected movements of agents within the economy under two different netting assumptions. I will let $\overline{X}$ denote the net expected movement of agents between any given neighborhood *i* and another neighborhood *j*, while $\overline{\overline{X}}$ will denote the net expected movement of agents between any given neighborhood *i* and all other neighborhoods. These two quantities, defined as $E\left[\left|x_{ij} - x_{ji}\right|\right]$ and $E\left[\left|\sum_{j=1}^{N}\left(x_{ij} - x_{ji}\right)\right|\right]$, respectively, are both positive, even though $E\left[x_{ij} - x_{ji}\right] = 0$ and $E\left[\sum_{j=1}^{N}\left(x_{ij} - x_{ji}\right)\right] = 0$. In words, the expected net movement of agents between neighborhoods *i* and *j in one direction or the other*, as well as the expected net movement between any given neighborhood *i* and *all other neighborhoods considered as a whole*, are both greater than zero. This is true even though no neighborhood experiences a net increase or decrease in its population *in expectation.* The important implication of these facts is that non-zero amounts of interbank settlement can be expected to occur even in a symmetric economy such as the one envisioned here. Note that $0 < \overline{\overline{X}} < \overline{X} < X < M$, and that, if we let $\left\{\overline{\overline{X}}_N\right\}$ represent a sequence of expectations as *N* becomes large, then $\lim_{N \to \infty} \overline{\overline{X}}_N = 0$, as an application of the law of large numbers.

Transporting the Good. Transporting the good from one neighborhood to another is costly. An amount S, $0 < S < 1$, is lost per unit of the good as soon as it is moved from its initial neighborhood.[2] This deadweight cost is incurred at most once. In autarky (*i.e.*, without banks) at T=0, each agent's expected utility of consumption at T=2 is therefore equal to the value of his or her endowment less the expected cost of moving it to another neighborhood, 1-S.

Banks. I assume that each neighborhood in the economy is served by a single profit-maximizing bank whose initial endowment consists of safe-keeping facilities and access to a risky lending opportunity if deposit funding becomes available (*i.e.,* if agents choose to deposit their endowment goods at banks). Let Z_i denote the risky payoff to bank i's loan if funded at T=0. I assume that the value of the loan follows some continuous process between T=0 and T=2 and that the creditors and/or regulators of the bank are able to monitor and seize the asset as soon as its value falls to a critical level, Z_F , which causes bank i's net worth-- net of all costs associated with interbank settlement and creditors' liquidation costs, if positive-- to equal zero. At T=0, each bank's probability of failing by T=2 is f, $0<f<1$. As long as Z_i remains above the critical level, no intervention is undertaken. In what follows, I will examine the situation that results from the failure of a single bank; the first failure of a bank therefore defines the "end" of this economy (T=2).

Each bank accepts deposits of the consumption good from all local agents at T=0 (subject to voluntary-participation and incentive-compatibility constraints) and issues receipts against these deposits that promise the amount R of the good at T=2. Banks in this economy collectively constitute a payment system in the sense that I assume they are able to *precommit* to issuing new deposit receipts of their own in exchange for the deposit receipts of other banks delivered to them by newly arriving agents. Since all banks are identical *ex ante* and interbank co-operation raises expected profits, it is reasonable for all banks to agree to participate in this payment arrangement so long as there are enforcement mechanisms ensuring that no individual bank, or a subset of banks, will defect at T=1 by refusing to exchange another bank's deposits at par. It is this web of co-operative agreements-- perhaps re-inforced by statute or regulation-- that characterizes the unique interdependent nature of payment systems. Although this nexus of explicit and implicit contracts represents an interesting future research topic, I simply assume for present purposes that depositors and banks fully expect to trade deposit receipts issued by various banks at par.

Consistent with my assumption that banks are local monopolists, I assume that agents who deposit their consumption good at T=0 receive only their reservation utility in expectation. With banks operating under a regime of no deposit insurance, each agent holding the deposit receipt of a failed bank must seek to recover his or her endowment; this expected liquidation cost is fL per agent. The agents' voluntary-participation constraint thus requires a bank deposit contract net of expected liquidation costs, R-fL, to provide in expectation at least the value of his or her endowment less the cost of moving it to another neighborhood, 1-S. Therefore, participation of all agents will be assured by banks promising R+fL=1-S+fL when no deposit insurance exists. With deposit insurance, depositors demand only R=1-S.

Gross settlement of interbank payments occurs as follows. At T=0, any given bank i's balance sheet consists only of the risky loan, deposits, and owner's equity (a residual of loan value over deposit promises, since the banker contributes no equity of his own):

Bank i's Balance Sheet at T=0

Risky loan	Z_i	$M(R+fL)$	Initial deposit obligations
		NW_0	Net worth

The risky loan will pay off in period two, so its value at T=0-- and therefore, the bank's net worth-- is a random variable. The bank's initial deposit obligations are to the M depositors who originate in neighborhood i and who will move to the other N-1 neighborhoods in the economy. Bank i's depositors will take their deposit receipts with them and trade them for deposits in their new location.

Geographic-preference shocks are realized and acted upon in period one. Upon arrival in neighborhood j at T=1, the holder of a deposit receipt from bank i trades the bank i deposit for a bank j deposit, which promises an amount R+fL of the consumption good in neighborhood j at T=2. Each bank's original deposit obligations can now be specified as due-to balances that will be collected by the other banks in the economy at T=2 (in amount $\sum_{j=1}^{N} x_{ij}(R+fL)$). Depositor arrivals, meanwhile, generate both a set of N-1 interbank claims in favor of bank i (valued at $\sum_{j=1}^{N} x_{ji}(R+fL)(1-S)$, since settlement costs are incurred by due-from banks) and a set of additional deposit obligations to the newly arrived agents (with face value $\sum_{j=1}^{N} x_{ji}(R+fL)$).[3] Since no information has arrived about the values of banks' risky loans, expectations about banks' net worth remain unchanged. Bank i's balance sheet thus appears as follows:

Bank i's Balance Sheet at T=1

Loan value	Z_i	$\sum_{j=1}^{N} x_{ij}(R+fL)$	Initial deposit obligations = Due-to balances
Due-from balances	$\sum_{j=1}^{N} x_{ji}(R+fL)(1-S)$	$\sum_{j=1}^{N} x_{ji}(R+fL)$	Additional deposit obligations
		NW_1	Net worth

To complete the description of interbank payments without netting agreements or deposit insurance, I must specify liquidation costs and failure-resolution procedures. Each bank in the economy is subject to failure because it invests the consumption good deposited with it in a risky project. Although a bank could, in principle, also fail as a result of losses it suffers on its interbank claims, I rule out this possibility in what follows. Assigning a probability of zero to a "domino-effect" scenario appears reasonable for two reasons in the present context: 1) a domino effect is not necessary to demonstrate the marginal efficiency trade-off between risk-bearing schemes relying on depositors (hence, the deposit insurer) alone and the entire set of bank creditors, including interbank claimants, unless one believes there are important externalities associated with bank failures; and 2) recent initiatives by private- and public-sector participants in the major large-dollar payment systems to control interbank credit exposures, as well as extensive explicit and implicit government guarantees, make a cascade of major bank failures exceedingly unlikely in the near future.[4]

As noted above, a bank failure occurs at the instant in period two at which the failing bank's loan value reaches a critical lower level, Z_F.[5] When this occurs, the bank is insolvent (by definition) and liquidation costs are incurred by the bank's creditors according to the predetermined rules associated with the settlement regime in place. Absent deposit insurance, all banks that hold due-from claims on the failing bank incur the liquidation (or state-verification) cost of L, which is deducted from the liquidation proceeds. At the same time, all the agents whose geographic-preference shocks caused them to move to the neighborhood in which the bank failed must also incur the liquidation cost, since they hold the failed bank's deposits. An insolvent bank i's balance sheet at the instant it becomes insolvent is the following:

Bank i's Balance Sheet at Failure (T=2)

Loan value	Z_F	$\sum_{j=1}^{N} x_{ij}(R+fL)$	Initial deposit obligations = Due-to balances
Due-from balances	$\sum_{j=1}^{N} x_{ji}(R+fL)(1-S)$	$\sum_{j=1}^{N} x_{ji}(R+fL)$	Additional deposit obligations
		0	Net worth

The balance sheet of another representative bank appears as follows:

Bank j's Balance Sheet at T=2

Loan value	Z_j	$\sum_{j'=1}^{N} x_{jj'}(R+fL)$	Initial deposit obligations = Due-to balances
Due-from balances	$\sum_{j'=1}^{N} x_{j'j}(R+fL)(1-S)-L$	$\sum_{j'=1}^{N} x_{j'j}(R+fL)$	Additional deposit obligations
		NW_2	Net worth

The agents who arrived at bank i (numbering $(N\text{-}1)X$ in expectation and $\sum_{j'=1}^{N} x_{jj'}$ in fact) are each able to consume only $1\text{-}S\text{+}fL\text{-}L$, or $1\text{-}S\text{-}(1\text{-}f)L$, while all agents in other banks consume $1\text{-}S\text{+}fL$.

Total Deadweight Costs. The total deadweight costs incurred in a system with gross settlement of interbank payments consist of settlement and liquidation costs. Total costs of settlement are $\sum_{i=1}^{N}\sum_{j=1}^{N} x_{ij}(R + fL)S$. Since every single creditor sues the failed bank for payment, each creditor thereby incurs liquidation costs of L. Total liquidation costs incurred as a result of bank i's failure are therefore $\left[(N-1)+\sum_{j=1}^{N} x_{ji}\right]L$.

II. Deposit Insurance

In this and subsequent sections, I ask the following question: How would a given set of payment-system arrangements including deposit insurance and interbank netting agreements differ from the gross-settlement system described above in the presence of a single bank failure? In particular, how would the losses be shared and what are the deadweight costs incurred?

I model a deposit insurer as a profit-maximizing institution that is constrained (perhaps by law) to break even in expectation. The fair deposit-insurance premium per unit of deposits, p, is derived from the deposit insurer's break-even condition, $NP(1\text{-}S) - L = 0$, where P represents the average deposit-insurance premium per bank, or $P = Mp$. Since $P = L/[N(1\text{-}S)]$ from the zero-profit constraint, the premium rate per unit of deposits, p, is $L/[MN(1\text{-}S)]$. This obligation appears on the balance sheet of all banks as of T=1 after all agents have reached their new locations, but is not payable until T=2, when all other payment obligations are settled. The purpose of a deposit insurer here is solely to serve as the delegated monitor (in Diamond's (1984) sense) of all banks on behalf of depositors. Since any bank that approaches insolvency is closed immediately when its net worth, net of all costs, reaches zero, the deposit insurer never absorbs any losses. Deposit insurance is welfare-enhancing even though there is no insurance reserve.[6]

Each bank's interim (T=1) balance sheet differs from the previous case because the deposit interest rate is now simply R=1-S, which benefit is offset to some extent by the obligation to pay a deposit-insurance premium, P:

Bank i's Balance Sheet at T=1 With Deposit Insurance

Risky loan	Z_i	$\sum_{j=1}^{N} x_{ij} R$	Initial deposit obligations = Due-to balances
Due-from balances	$\sum_{j=1}^{N} x_{ji} R(1-S)$	$\sum_{j=1}^{N} x_{ji} R$	Additional deposit obligations
		$p\sum_{j=1}^{N} x_{ji} R$	Deposit-insurance premium
		NW_1	Net worth

A bank that fails has net worth precisely equal to zero, net of all settlement and liquidation costs:

Bank i's Balance Sheet at Failure (T=2) With Deposit Insurance

Loan value	Z_F	$\sum_{j=1}^{N} x_{ij} R$	Initial deposit obligations = Due-to balances
Due-from balances	$\sum_{j=1}^{N} x_{ji} R(1-S)$	$\sum_{j=1}^{N} x_{ji} R$	Additional deposit obligations
		$p\sum_{j=1}^{N} x_{ji} R$	Deposit-insurance premium
		0	Net worth

All solvent banks pay the deposit-insurance premium but avoid direct liquidation costs:

Bank j's Balance Sheet at T=2 With Deposit Insurance

Loan value	Z_j	$\sum_{j'=1}^{N} x_{jj'} R$	Initial deposit obligations = Due-to balances
Due-from balances	$\sum_{j'=1}^{N} x_{j'j} R(1-S)$	$\sum_{j'=1}^{N} x_{j'j} R$	Additional deposit obligations
		$p\sum_{j'=1}^{N} x_{j'j} R$	Deposit-insurance premium
		NW_2	Net worth

Finally, the deposit insurer just breaks even:

Deposit Insurer's Balance Sheet at T=2

Deposit-insurance premiums	$NP(1\text{-}S)$	L	Allowance for liquidation costs
		0	Net worth

Total Deadweight Costs. Total deadweight costs incurred in a system with deposit insurance and gross settlement of interbank payments consist of settlement and liquidation costs. Total costs of settlement are $\sum_{i=1}^{N}\sum_{j=1}^{N} x_{ij} RS + NPS$. Since only the deposit insurer sues the failed bank for payment, total liquidation costs are L. A trade-off of higher settlement costs against lower liquidation costs defines the potential benefit of deposit insurance as delegated monitoring. Figure 1 compares expected deadweight costs under various payment arrangements.

III. Interbank Netting Agreements

The reason interbank netting agreements may lower systemic risk is that they tend to reduce direct credit exposures between banks. This procedure is expedient from the standpoint of banks (including the central bank) that wish to avoid the inter-bank transmission of economic losses. However, subjecting a subset of a bank's liabilities to a netting agreement also alters the previously existing risk-sharing arrangements among the bank's creditors. In essence, netting imposes a *de facto* seniority structure on a bank's liabilities even when none exists *de jure*. This occurs because bank *j*'s claims on bank *i* that are included in a netting agreement are satisfied by extinguishing an equivalent amount of bank *i*'s claims on bank *j as calculated at face values.* If the true market value of bank *i*'s liabilities is less than their face value, then netting at face values represents a transfer of value from non-netting claimants toward creditors of bank *i* that are included in the netting agreement.

Bilateral Netting Agreements. The simplest type of interbank netting agreement is one that obliges two banks, say bank *i* and bank *j*, to settle only the difference between the respective banks' claims on each other. In the notation of this paper, bilateral netting reduces the total transfer of the settlement medium undertaken by the two banks from $\left(x_{ij}+x_{ji}\right)$ to $\left|x_{ij}-x_{ji}\right|$, with a corresponding reduction in the total deadweight cost of settlement. For simplicity in what follows, I examine the case in which (only) bank *i* eventually fails. Since the index is chosen arbitrarily, I assume without loss of generality that bank *i* realizes a net due-from balance *vis-a-vis* banks 1, 2,...,*i*-1 (*i.e.,* $x_{ij}-x_{ji}<0$), and simultaneously realizes a net due-to balance *vis-a-vis* banks *i*+1,...,*N* (*i.e.,* $x_{ij}-x_{ji}>0$). Bank *i*'s balance sheet then appears as follows:

Bank i's Balance Sheet at T=1 With Bilateral Netting Agreements and Deposit Insurance

Risky loan	Z_i	$\sum_{j=1}^{N} x_{ji} R$	Deposits
Due-from balances	$\sum_{j=1}^{i-1} \left(x_{ji} - x_{ij}\right) R(1-S)$	$\sum_{j=i+1}^{N} \left(x_{ij} - x_{ji}\right) R$	Due-to balances
		$p\sum_{j=1}^{N} x_{ji} R$	Deposit-insurance premium
		NW_1	Net worth

Notice that due-from and due-to balances are strictly smaller than was the case under gross settlement. The important implication of this fact is that bank i's total liabilities have been reduced, while the amount of insured deposits-- $\sum_{j=1}^{N} x_{ji} R$ -- has not changed. Thus, the proportion of total liabilities represented by insured deposits has increased.

It is now possible to state one version of the paper's main result, namely, that the existence of an interbank netting agreement shifts bank default risk toward bank creditors whose claims are not included in the netting agreement.

<u>Result 1</u>. The deposit insurer bears a larger proportion of any economic loss arising from a bank failure under a bilateral interbank netting agreement than under a gross settlement regime.

<u>Proof</u>. Compare the expected T=2 liability structure (viewed at T=0) of bank i both with and without the bilateral netting agreement. This liability structure implies the sharing rule that

would apply among the failed bank's various liability holders if a marginal economic loss of ε were to occur (that is, if Z_i were allowed to go below Z_F by the amount ε).

Bank i's expected liabilities under gross settlement are

$$E\left[\sum_{j=1}^{N} x_{ij} R\right] + (1+p)E\left[\sum_{j=1}^{N} x_{ji} R\right] = (2+p)(N-1)XR$$

but the contingent liability of the deposit insurer includes only bank i's deposits, or $(N\text{-}1)XR$, out of a total of $2(N\text{-}1)XR$ owed by bank i to the other banks and agents in the economy (*i.e.,* excluding the deposit insurer). Hence, the proportion of incremental bank default risk borne by the deposit insurer is exactly one half under a gross-settlement regime.

Bank i's expected liabilities under bilateral net settlement are the following (excluding deposit-insurance premiums, which net out from the deposit insurer's perspective):[7]

$$E\left[\sum_{j=1}^{N} x_{ij} R\right] + (1/2)\sum_{j=1}^{N} E\left[\left|x_{ij} - x_{ji}\right|\right]R = (N-1)XR + (1/2)N\overline{X}R\,.$$

The proportion of incremental bank default risk borne by the deposit insurer is

$$\frac{(N-1)XR}{(N-1)XR + (1/2)N\overline{X}R} = \frac{X}{X + \left(N/2(N-1)\right)\overline{X}} > \frac{1}{2}$$

since $(N/2(N-1))\overline{X} < \overline{X} < X$ for N>2 and therefore $(N/2(N-1))\overline{X} < X$. But this proves that the deposit insurer bears a larger proportion of any incremental bank default risk under a bilateral interbank netting agreement than under a gross settlement regime, as asserted. Q.E.D.

Multilateral netting. The presence of a multilateral interbank netting agreement unambiguously increases the degree to which bank default risk is shifted to the class of non-netted bank liabilities (insured deposits in this model). While the risk exposure of other banks to a given bank *i* may be positive or zero, depending on bank *i*'s balance at the clearinghouse (*i.e.,* after multilateral netting of interbank claims), the same is not true of the deposit insurer. To see this, examine the balance sheet of bank *i* under two different cases, that of net due-from and net due-to balances:

Bank *i*'s Balance Sheet at T=1 With A Multilateral Netting Agreement and Deposit Insurance: Net Due-From Balance

Risky loan	Z_i	$\sum_{j=1}^{N} x_{ji} R$	Deposits
Due-from balance at clearinghouse	$\sum_{j=1}^{N} (x_{ji} - x_{ij}) R(1-S)$	0	Due-to balance at clearinghouse
		$p\sum_{j=1}^{N} x_{ji} R$	Deposit-insurance premium
		NW_I	Net worth

It is clear in the case of a net due-from balance that the deposit insurer bears more of the default risk of bank *i* than without netting; in fact, the deposit insurer bears 100% of the incremental risk represented by any deviation of Z_i below the critical level of Z_F. It is less obvious, although also true, that the deposit insurer bears more default risk when the insured bank holds a net due-to position at the clearinghouse:

Bank i's Balance Sheet at T=1 With A Multilateral Netting Agreement and Deposit Insurance: Net Due-To Balance

Risky loan	Z_i	$\sum_{j=1}^{N} x_{ji} R$	Deposits
Due-from balance at clearinghouse	0	$\sum_{j=1}^{N} (x_{ij} - x_{ji}) R$	Due-to balance at clearinghouse
		$p \sum_{j=1}^{N} x_{ji} R$	Deposit-insurance premium
		NW_1	Net worth

This leads to the second version of the paper's main result.

Result 2. The deposit insurer bears a larger proportion of bank default risk under a multilateral interbank netting agreement than under either a gross settlement regime or a bilateral interbank netting agreement.

Proof. Compare the expected T=2 liability structure (viewed at T=0) of bank i with a multilateral netting agreement, with a bilateral netting agreement, and with no interbank netting agreement. Once again, note that the liability structure implies the sharing rule that would apply among the failed bank's various liability holders if a marginal economic loss of ε were to occur (that is, if Z_i were allowed to go below Z_F by the amount ε). Bank i's expected liabilities (excluding the deposit-insurance premium) under gross settlement and under bilateral netting were shown in the proof of Result 1. Bank *i*'s expected liabilities (excluding the deposit-insurance premium) under multilateral netting with a net due-to balance are:

$$E\left[\sum_{j=1}^{N} x_{ij} R\right] + (1/2)E\left[\sum_{j=1}^{N} \left|x_{ij} - x_{ji}\right| R\right] = (N-1)XR + (1/2)N\overline{\overline{X}}R\,.$$

The proportion of bank default risk borne by the deposit insurer is

$$\frac{(N-1)XR}{(N-1)XR + (1/2)N\overline{\overline{X}}R} = \frac{X}{X + \left(N/2(N-1)\right)\overline{\overline{X}}} > \frac{1}{2}$$

since $\left(N/2(N-1)\right)\overline{\overline{X}} < \overline{\overline{X}} < X$ for N>2 and therefore $\left(N/2(N-1)\right)\overline{\overline{X}} < X$, which proves that the deposit insurer bears a larger proportion of any incremental economic loss arising from a bank failure under a multilateral interbank netting agreement than under a gross settlement regime.

The second part of the assertion holds if

$$\frac{X}{X + \left(N/2(N-1)\right)\overline{\overline{X}}} > \frac{X}{X + \left(N/2(N-1)\right)\overline{X}}$$

but this follows directly from the fact that $\overline{\overline{X}} < \overline{X}$. Q.E.D.

Note that, in the limit-- that is, as the number of independent banks included in a multilateral netting agreement increases without bound-- the proportion of bank default risk borne by the deposit insurer approaches one. This is because the sum of net interbank balances approaches zero.[8] In practice, a large multilateral netting agreement may approach this limit with as few as a hundred members. CHIPS (the Clearing House Interbank Payment System), for example, reportedly achieves netting ratios in the neighborhood of 95% in its daily clearings.

IV. Illustration of Interbank Netting Agreements in the Foreign-Exchange Market

In this section, I illustrate the risk shifting that occurs in the presence of interbank netting agreements with an example set in the context of the foreign-exchange market. I then briefly discuss the role of a central bank in the presence of interbank netting agreements.

Interbank Netting Agreements and the Distribution of Bank Default Risk in the Foreign-Exchange Market: An Example. Consider three banks, headquartered in the U.S., Canada, and the U.K., respectively. Suppose that, in the course of one day, the U.S. bank (Bank 1) agrees to purchase Canadian dollars from the Canadian bank (Bank 2) and agrees to sell a like amount of Canadian dollars to the U.K. bank (Bank 3). Meanwhile, Bank 2 agrees to purchase British pounds from Bank 3 in return for U.S. dollars. The specific delivery obligations that arise are the following (where "USD" means U.S. dollars, "CD" means Canadian dollars, and "BP" means British pounds):

- Bank 1 owes Bank 2 USD 30 million;
- Bank 1 owes Bank 3 CD 40 million;
- Bank 2 owes Bank 1 CD 40 million;
- Bank 2 owes Bank 3 USD 30 million;

- Bank 3 owes Bank 1 USD 30 million;
- Bank 3 owes Bank 2 BP 20 million.

The banks' simplified balance sheets in terms of their home currency appear as follows before any clearing or settlement of foreign-exchange transactions:

Bank 1's Balance Sheet

Other assets		USD Z_1	USD D_1	Insured deposits
Due-from balances (DF_1)		USD 60 mn	USD 60 mn	Due-to balances (DT_1)
Bank 2	CD 40 mn		USD 30 mn	Bank 2
Bank 3	USD 30 mn		CD 40 mn	Bank 3
			USD OL_1	Other liabilities (uninsured)
			USD NW_1	Net worth

Bank 2's Balance Sheet

Other assets		CD Z_2	CD D_2	Deposits and other liabilities
Due-from balances (DF_2)		CD 80 mn	CD 80 mn	Due-to balances (DT_2)
Bank 1	USD 30 mn		CD 40 mn	Bank 1
Bank 3	BP 20 mn		USD 30 mn	Bank 3
			CD NW_2	Net worth

Bank 3's Balance Sheet

Other assets		BP Z_3	BP D_3	Deposits and other liabilities
Due-from balances (DF_3)		BP 40 mn	BP 40 mn	Due-to balances (DT_3)
Bank 1	CD 40 mn		USD 30 mn	Bank 1
Bank 2	USD 30 mn		BP 20 mn	Bank 2
			BP NW_3	Net worth

Now suppose Bank 1's net worth is determined by its regulator to have fallen to a critical point that is just sufficient to cover the costs of resolving the bank; in other words, Z_1 has fallen to Z_F and NW_1 is written down to zero. If the regulator subsequently discovers that the true loss on Bank 1's assets turns out be some positive amount, say $10 million, how will this loss be shared among the bank's depositors, creditors, and the deposit insurer?

In a gross-settlement regime, the general creditors of Bank 1 have claims totalling $D_1+DT_1+OL_1$ (I am assuming that all of the bank's "other liabilities" are uninsured deposits; non-deposit claims are subordinated to deposits under FDICIA's "depositor-preference" regulations). The FDIC's share of Bank 1's losses are $D_1/(D_1+DT_1+OL_1)$. If Bank 1 has a set of bilateral netting agreements for its U.S. dollar transactions with Banks 2 and 3, the FDIC share of Bank 1's losses remains $D_1/(D_1+DT_1+OL_1)$, since bilateral netting of the three banks' U.S. dollar transactions makes no difference in the settlement obligations due.[9]

The liability of the FDIC would be materially higher in this example in the presence of a multilateral netting agreement for U.S. dollar transactions, such as CHIPS, or if the banks agreed to net across all currencies simultaneously. To see this, first examine the three banks' balance sheets after multilateral netting of U.S. dollar transactions takes place:

Bank 1's Balance Sheet

Other assets	USD Z_1	USD D_1	Insured deposits
Due-from balances (DF_1)	USD 30 mn	USD 30 mn	Due-to balances (DT_1)
Bank 2	CD 40 mn	0	Bank 2
Bank 3	0	CD 40 mn	Bank 3
CHIPS	0	0	CHIPS
		USD OL_1	Other liabilities (uninsured)
		USD NW_1	Net worth

Bank 2's Balance Sheet

Other assets	CD Z_2	CD D_2	Deposits and other liabilities
Due-from balances (DF_2)	CD 40 mn	CD 40 mn	Due-to balances (DT_2)
Bank 1	0	CD 40 mn	Bank 1
Bank 3	BP 20 mn	0	Bank 3
CHIPS	0	0	CHIPS
		CD NW_2	Net worth

Bank 3's Balance Sheet

Other assets	BP Z_3	BP D_3	Deposits and other liabilities
Due-from balances (DF_3)	BP 20 mn	BP 20 mn	Due-to balances (DT_3)
Bank 1	CD 40 mn	0	Bank 1
Bank 2	0	BP 20 mn	Bank 2
CHIPS	0	0	CHIPS
		BP NW_3	Net worth

All interbank U.S. dollar claims are eliminated in this example *via* the multilateral netting agreement. Thus, the FDIC's share of Bank 1's losses becomes $D_1/(D_1+DT_1-30+OL_1)$, which is clearly greater than $D_1/(D_1+DT_1+OL_1)$, the original exposure discussed above. The holders of Bank 1's "other liabilities" also bear a larger share of any incremental loss on Bank 1's assets than was the case without multilateral netting of interbank U.S. dollar claims.

Netting across all currencies simultaneously in a series of bilateral agreements (*i.e.,* converting all obligations to a common-currency basis for netting, as in FXNET, a limited partnership operated by 12 major banks in London (BIS 1993, p. 497)) in fact reduces the net due-from and due-to balances for all three banks to zero in this example. This is because each of the foreign-exchange transactions in this illustration is the same size-- each contains one leg that equals USD 30 million. If all three banks agree to convert their interbank obligations to a common currency for purposes of bilateral netting, then all three banks are able to reduce their interbank exposures to zero without any settlement taking place. As a consequence, the FDIC's exposure to losses arising from Bank 1's assets becomes $D_1/(D_1+OL_1)$, which is larger still than the exposure under a multilateral netting agreement covering only U.S. dollar obligations. Obviously, the same result could be achieved more generally in a multilateral interbank netting agreement that converted all interbank obligations to a common currency for the purposes of multilateral clearing (as is done by MULTINET, a grouping of 11 North American banks, or ECHO, a clearinghouse being developed by several banks in London (BIS 1993, pp. 497-8)).

This illustration clearly demonstrates that interbank netting agreements reduce interbank credit exposures and, at the same time, shift bank default risk to bank creditors whose claims are not included in the netting agreements. For interbank netting agreements to live up to their potential as contributors to greater banking-sector stability, it must be the case that the risks they shift are adequately recognized and controlled by the parties accepting them, or at least, that the distortions in risk-bearing and -pricing they create are less costly in a welfare sense than are the systemic risks they replace.

The Role of Central Banks in the Presence of Interbank Netting Agreements. Central banks of major countries have been in the forefront of the proponents of interbank netting agreements, primarily because these agreements promise to reduce interbank credit exposures. A countervailing incentive faced by central banks is provided by their role as creditors (actual or potential) of large banks. Given their intimate knowledge of interbank markets and risks, it is not surprising that central banks are diligent in perfecting the collateral interests they hold in private banks. From an overall perspective, of course, this practice merely shifts bank default risk on to other creditors, such as the deposit insurer, although it could be argued that the financial integrity of central banks is an overriding public priority.

An important example of central bank credit exposures to private banks lies in the provision of payment services *via* transfers of central bank deposits in a gross settlement system with intraday credit extensions (overdrafts), as on Fedwire. The existence of interbank netting agreements reduces the need for banks to transact on Fedwire, but, at the same time, these agreements tend to concentrate bank default risk on the bank's remaining creditors, one of which may be the Federal Reserve in the form of a daylight overdraft. As noted above, the Fed is quite aware of the risk it bears in this context, and has implemented numerous safeguards, such as debit caps, collateral requirements, intraday monitoring, and overdraft pricing. To some extent, these safeguards may be seen as risk-reducing in the aggregate, since they may make bank default less likely. On the other hand, some of the credit-risk protection obtained by the Fed is purchased by shifting default risks on to other creditors.

V. Conclusion

FDICIA sought, among other policy goals, to reduce the extent of bank default risk borne by the FDIC and, ultimately, by the taxpayer. Various provisions of FDICIA indeed reduce the extent of bank losses likely to be imposed on the FDIC. Prompt corrective action, structured early intervention, and bank closure rules that allow the regulators to seize institutions before the book value of equity is exhausted may virtually eliminate multi-billion dollar deposit-insurer losses in the event of bank failure. Attempts to reduce regulators' incentives to declare a bank "too-big-to-fail" may also lower the FDIC's loss experience.

A less well-known aspect of FDICIA is its support of interbank netting agreements, which may be an important tool for reducing interbank, or systemic, risk. Bank failures as a result of interbank propagation of economic shocks would most likely create large losses for the FDIC. Hence, reduction of the risk of such episodes would appear to be consistent with FDICIA's emphasis on better protecting the FDIC's creditor interests in banks. This paper points out that a corollary of the systemic-risk reducing properties of interbank netting agreements is the shifting of bank default risk away from bank creditors whose claims are netted toward other creditors whose claims are not netted. In practice, this may mean that interbank claims and consequently interbank credit exposures are greatly reduced, while creditors such as the deposit insurer and holders of uninsured bank liabilities bear the economic risks avoided by other banks. The determination of the net welfare effects of interbank netting agreements is therefore not unambiguous. Future work may profitably provide quantitative estimates of the trade-offs described in this paper, or focus in more detail on the role of central banks in the payment system when potentially large amounts of bank default risk are being shifted among creditor groups.

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Figure 1. Comparison of Expected Deadweight Costs Incurred Under Various Payment Arrangements

Type of deadweight cost: **Settlement Regime**:	**1. Expected settlement costs**	**2. Expected liquidation costs**
Gross settlement	$MNX(R+fL)S$	$(N-1)(1+X)L$
Gross settlement with deposit insurance	$MNXRS+NPS$	L
Bilateral net settlement with deposit insurance	$(1/2)N(N-1)\overline{X}RS$ $+NPS$	L
Multilateral net settlement with deposit insurance	$(1/2)N\overline{\overline{X}}RS$ $+NPS$	L

Endnotes

[1] This device is meant to capture the notion that economic agents often need to transfer all or part of their wealth to another location or party. I define the payment system as that set of arrangements that facilitates the transfer of one's endowment.

[2] In a stylized model such as this, one could imagine a "leaky bucket" being used to carry the good (Calomiris and Kahn (1991)). In the context of a modern payment system, *S* represents all the real-resource costs associated with paying in cash or otherwise making final settlement.

[3] Note that the value of due-from claims is less than the value of the additional deposit obligations created. Clearly, every bank has the incentive to defect from the payment system by refusing to accept arriving depositors' claims at par. Recall that I simply assume that this violation of banks' interim voluntary participation constraint is overridden by unspecified enforcement mechanisms, such as regulation.

[4] This assumption may also be an accurate description of the post-FDICIA environment. Wall (1993) contends that, "In combination, these factors [*FDICIA's provisions*] should almost eliminate the risk that one bank's failure would cause insolvency at other banks (p. 5)."

[5] Although this assumption may not be realistic, it does, in fact, capture the intent of recent U.S. legislation: "FDICIA has mandated that regulators virtually eliminate deposit insurance losses (Wall, p. 11)."

[6] Clearly, if the deposit insurer is not perfectly able to close a bank when it becomes insolvent, some losses may occur. A pre-funded insurance reserve to pay off insured depositors would be desirable in this case if the deposit insurer's access to liquidity is limited or costly.

[7] See Cohen and Roberds (1993, p. 6) for a discussion of required settlement flows under gross, bilateral net, and multilateral net settlement regimes.

[8] In other words, the "netting ratio" approaches 100%, where this ratio is defined as the portion of gross settlement obligations that are satisfied by offsetting claims in the clearing procedure (and hence, do not result in any of the settlement medium being transferred).

[9] Bilateral agreements that net interbank obligations across all three of the currencies simultaneously would make an important difference, however, as discussed below.